Programming Project #2: Image Quilting

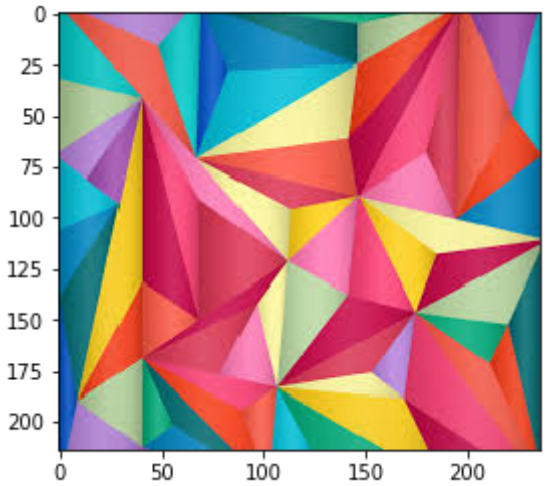
CS445: Computational Photography - Fall 2019

In [1]:
```
import random
import cv2
import numpy as np
import matplotlib.pyplot as plt
%matplotlib notebook
import utils
import os
```

In [2]:
```
from utils import cut # default cut function for seam finding section
```

Part I: Randomly Sampled Texture (10 pts)

In [3]:
```
sample_img_dir = 'image/texture1.jpg' # feel free to change
sample_img = None
if os.path.exists(sample_img_dir):
    sample_img = cv2.imread(sample_img_dir)
    sample_img = sample_img.astype(np.float32)/255.0
    plt.imshow(sample_img[...,-1::-1])
```



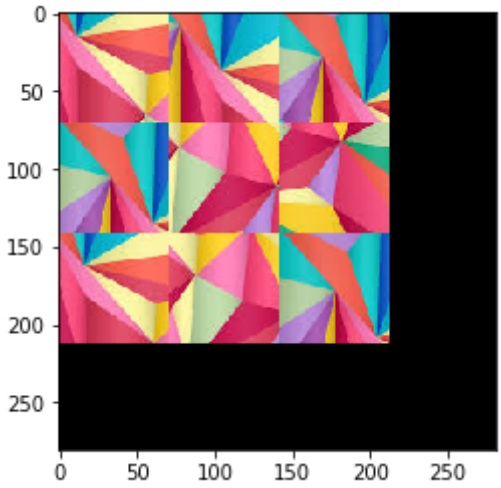
In [4]:
```
sample_img.shape
```

Out[4]:
```
(214, 236, 3)
```

In [5]:
```
def quilt_random(sample, out_size, patch_size):
    """
    Randomly samples square patches of size patchsize from sample in order to

    :param sample: numpy.ndarray   The image you read from sample directory
    :param out_size: int            The width of the square output image
    :param patch_size: int          The width of the square sample patch
    :return: numpy.ndarray
    """
    output = np.zeros((out_size,out_size,3), dtype=np.float32)
    number = out_size // patch_size
    # plt.imshow(patch_selected)
    for i in range (number):
        for j in range (number):
            a = random.randint(0,sample.shape[0]-patch_size)
            patch_selected = sample[a:a+patch_size,a:a+patch_size]
            output[i*patch_size:(i+1)*patch_size,j*patch_size:(j+1)*patch_size
    # ball = img[20:30,30:30]
    # img[30:40,30:30] = ball
    return output
ssd = (np.sum((mask*template)**2)) - 2 * cv2.filter2D(sample, cv2.CV_64F, ma
```

In [6]:
```
out_size = 281  # feel free to change to debug
patch_size = 71 # feel free to change to debug
res = quilt_random(sample_img, out_size, patch_size)
plt.imshow(res[...,-1::-1])
```

Out[6]: <matplotlib.image.AxesImage at 0x11d41ca20>



Part II: Overlapping Patches (30 pts)

In [67]:
```
import math
# Suppose I have a template T, a mask M, and an image I: then,
# ssd = ((M*T)**2).sum() - 2 * cv2.filter2D(I, ddepth=-1, kernel = M*T) + cv
def ssd_patch(sample, patch_size, template, mask):
    """
    ssd_patch performs template matching with the overlapping region, comput
    each patch, based on the sum of squared differences (SSD) of the overlap
    and sampled patch.
    """
    start_index = (patch_size-1) // 2
    end_index = (sample.shape[0]-1) - start_index # end index is 191-9=182,
#     print("template")
#     plt.imshow(template)
#     plt.show()
#     print("mask")
#     plt.imshow(mask)
#     plt.show()
#     print("sample")
#     plt.imshow(sample)
#     plt.show()
    ssd = ((mask*template)**2).sum() - 2 * cv2.filter2D(sample, ddepth=-1, k
#     plt.imshow(ssd.mean(2)) !!!!!!!!!!
#     plt.show()
    sample_size = sample.shape[0]
    cost_image = np.zeros((sample_size,sample_size), dtype=np.float32)
    for i in range(start_index,end_index+1):
        for j in range(start_index,end_index+1):
            cost_image[i,j] = ssd[i,j].sum()
#     print("cost image")
#     print(cost_image)
#     plt.imshow(cost_image)
#     plt.show()
    return cost_image
```

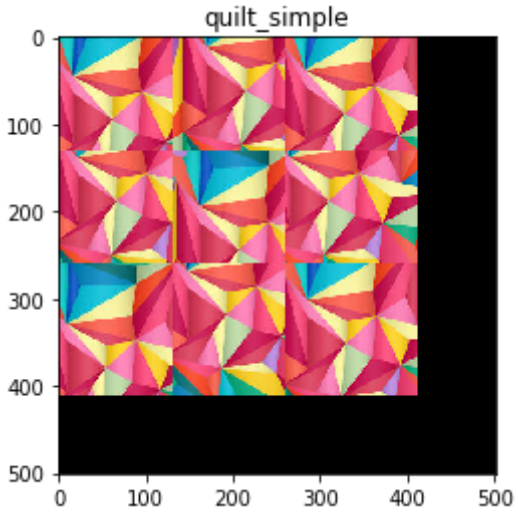
In [77]:
```
def choose_sample(sample, patch_size, cost_image, tol):
    # for sample.shape = (192,192,3) and patch_size = 19 and overlap = 5
    start_index = (patch_size-1) // 2 # start index is (19-1)/2=9
    end_index = (sample.shape[0]-1) - start_index  # end index is 191-9=182,
    minc = float("inf")
    # first to find the min cost
    for i in range (start_index,end_index+1):
        for j in range (start_index,end_index+1):
            if cost_image[i,j] < minc:
                minc = cost_image[i,j]
    compare_cost = minc*(1+tol)
    for i in range (start_index,end_index+1):
        for j in range (start_index,end_index+1):
            if cost_image[i,j] < compare_cost:
                return i,j
```

In [78]:
```
def quilt_simple(sample, out_size, patch_size, overlap, tol):
    """
    Randomly samples square patches of size patchsize from sample in order t
    Feel free to add function parameters
    :param sample: numpy.ndarray
    :param out_size: int
    :param patch_size: int
    :param overlap: int
    :param tol: int
    :return: numpy.ndarray
    """
    output = np.zeros((out_size,out_size,3), dtype=np.float32)
    patch_size_remained = patch_size - overlap
    number = (out_size - patch_size) // patch_size_remained + 1 # the numbe
    # Start by sampling a random patch for the upper-left corner.
    k = (patch_size-1) // 2
    a = random.randint(0,sample.shape[0]-patch_size)
    b = random.randint(0,sample.shape[0]-patch_size)
#     a = 0
#     b = 0
    output[0:patch_size,0:patch_size] = sample[a:a+patch_size,b:b+patch_size
    print(a,b)
    # the second patch along the top row will overlap by patch_size
    # pixels in the vertical direction and overlap pixels in the horizontal
    for h_left_index in range (0,number):
        for w_left_index in range (0,number):
            # The mask has the same size as the patch template and
            # has values of 1 in the overlapping region and values of 0 else
            mask = np.zeros((patch_size,patch_size,3), dtype=np.float32)
            # the coordinate of the left_top point is (x_left_top*patch_size
            if (w_left_index == 0) and (h_left_index == 0):
                mask[:,0:overlap] = 1.0
                mask[0:overlap,:] = 1.0
                continue
            elif (h_left_index == 0):
                mask[:,0:overlap] = 1.0
            elif (w_left_index == 0):
                mask[0:overlap,:] = 1.0
            else:
                mask[:,0:overlap] = 1.0
                mask[0:overlap,:] = 1.0
            h_left = h_left_index * patch_size_remained
            w_left = w_left_index * patch_size_remained
            #  The template is the patch in the current output image that is
            # (many pixel values will be 0 because they are not filled in ye
            template = output[h_left:h_left+patch_size,w_left:w_left+patch_s
#             plt.imshow(mask)
#             plt.show()
#             print(mask)
            cost_image = ssd_patch(sample, patch_size, template, mask)
            i ,j = choose_sample(sample, patch_size, cost_image, tol)
            output[h_left:h_left+patch_size,w_left:w_left+patch_size] = samp
            # the same as the patch_size
    return output
```

In [79]:
```
res = quilt_simple(sample_img, 501, 151, 21, 0.0000001) #feel free to change
plt.imshow(res[...,-1::-1]) # overlap 0.005 is not enough while 0.0005 is en
plt.title('quilt_simple')
```

```
26 51
```

Out[79]:
```
Text(0.5, 1.0, 'quilt_simple')
```



In [80]:
```
#     plt.figure()
#     plt.imshow(im1_lowpass, cmap='gray')
#     plt.axis('off')
#     plt.savefig('./image/dog_filter_low.jpg')
```

Part III: Seam Finding (20 pts)

In [12]:
```
# optional or use cut(err_patch) directly
def customized_cut(bndcost):
    pass
```

In [13]:
```
def calculate_err(overlap_origin,overlap_sample):
    h = overlap_origin.shape[0]
    w = overlap_origin.shape[1]
    overlap_diff = overlap_origin - overlap_sample
    overlap_diff = np.square(overlap_diff)
    err_patch = np.zeros((h,w),dtype=np.float32)
    for i in range (h):
        for j in range (w):
            err_patch[i,j] = overlap_diff[i][j].sum()
    return err_patch
```

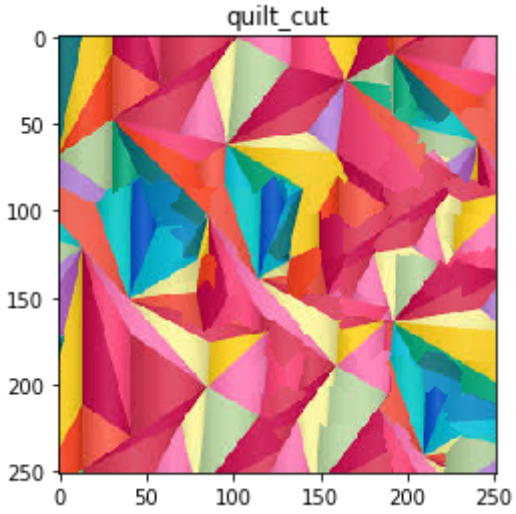
In [14]:
```
def quilt_cut(sample, out_size, patch_size, overlap, tol):
    """
    Samples square patches of size patchsize from sample using seam finding
    Feel free to add function parameters
    :param sample: numpy.ndarray
    :param out_size: int
    :param patch_size: int
    :param overlap: int
    :param tol: int
    :return: numpy.ndarray
    """
    output = np.zeros((out_size,out_size,3), dtype=np.float32)
    patch_size_remained = patch_size - overlap
    number = (out_size - patch_size) // patch_size_remained + 1 # the numbe
    # Start by sampling a random patch for the upper-left corner.
    k = (patch_size-1) // 2
    a = random.randint(0,sample.shape[0]-patch_size)
    b = random.randint(0,sample.shape[0]-patch_size)
#     a = 0
#     b = 0
    output[0:patch_size,0:patch_size] = sample[a:a+patch_size,b:b+patch_size
    print(a,b)
    # the second patch along the top row will overlap by patch_size
    # pixels in the vertical direction and overlap pixels in the horizontal
    for h_left_index in range (0,number):
        for w_left_index in range (0,number):
            # The mask has the same size as the patch template and
            # has values of 1 in the overlapping region and values of 0 else
            mask = np.zeros((patch_size,patch_size,3), dtype=np.float32)
            # the coordinate of the left_top point is (x_left_top*patch_size
            if (w_left_index == 0) and (h_left_index == 0):
                mask[:,0:overlap] = 1.0
                mask[0:overlap,:] = 1.0
                continue
            elif (h_left_index == 0):
                mask[:,0:overlap] = 1.0
            elif (w_left_index == 0):
                mask[0:overlap,:] = 1.0
            else:
                mask[:,0:overlap] = 1.0
                mask[0:overlap,:] = 1.0
            h_left = h_left_index * patch_size_remained
            w_left = w_left_index * patch_size_remained
            #  The template is the patch in the current output image that is
            # (many pixel values will be 0 because they are not filled in ye
            template = output[h_left:h_left+patch_size,w_left:w_left+patch_s
            cost_image = ssd_patch(sample, patch_size, template, mask)
            i ,j = choose_sample(sample, patch_size, cost_image, tol)
            # output[h_left:h_left+patch_size,w_left:w_left+patch_size] = sa
            # the same as the patch_size
            # added code for quilt_cost ----------------------------------
            # the situdation of left overlaps
            if (h_left_index == 0):
                overlap_origin = output[h_left:h_left+patch_size,w_left:w_le
                overlap_sample = sample[i-k:i-k+patch_size, j-k:j-k+overlap]
```

```
                err_patch = calculate_err(overlap_origin,overlap_sample)
                mask = cut(err_patch.T)
                mask = mask.T
                h,w = mask.shape
                mask_handle = np.zeros((h,w,3), dtype = np.float32)
                # convert int to float, can't find easier way
                for a in range(h):
                    for b in range(w):
                        if mask[a,b] == 1:
                            for c in range(3):
                                mask_handle[a,b,c] = 1.0
                        else:
                            for c in range(3):
                                mask_handle[a,b,c] = 0.0
                overlap_mix = overlap_origin*(1-mask_handle) + overlap_sampl
                output[h_left:h_left+patch_size,w_left:w_left+patch_size] =
                output[h_left:h_left+patch_size,w_left:w_left+overlap] = ove
            # the situdation of top overlaps
            elif (w_left_index == 0):
                overlap_origin = output[h_left:h_left+overlap,w_left:w_left+
#                 plt.imshow(overlap_origin[...,-1::-1])
#                 plt.show()
                overlap_sample = sample[i-k:i-k+overlap, j-k:j-k+patch_size]
#                 plt.imshow(overlap_sample[...,-1::-1])
#                 plt.show()
                err_patch = calculate_err(overlap_origin,overlap_sample)
#                 print("cost")
#                 plt.imshow(err_patch[...,-1::-1])
#                 plt.show()


                mask = cut(err_patch)
                h,w = mask.shape
                mask_handle = np.zeros((h,w,3), dtype = np.float32)
                # convert int to float, cannot find easier way
                for a in range(h):
                    for b in range(w):
                        if mask[a,b] == 1:
                            for c in range(3):
                                mask_handle[a,b,c] = 1.0
                        else:
                            for c in range(3):
                                mask_handle[a,b,c] = 0.0
#                 temp1 = overlap_origin*(1-mask_handle)
#                 plt.imshow(temp1[...,-1::-1])
#                 plt.show()
#                 temp2 = overlap_sample*mask_handle
#                 plt.imshow(temp2[...,-1::-1])
#                 plt.show()
                overlap_mix = overlap_origin*(1-mask_handle) + overlap_sampl
#                 plt.imshow(overlap_mix[...,-1::-1])
#                 plt.show()
                output[h_left:h_left+patch_size,w_left:w_left+patch_size] =
                output[h_left:h_left+overlap,w_left:w_left+patch_size] = ove
            # if a patch has top and left overlaps, you will need to compute
            # and the mask can be defined as the intersection of the masks i
            else:
```

```
                # left overlaps part
                overlap_origin = output[h_left:h_left+patch_size,w_left:w_le
                overlap_sample = sample[i-k:i-k+patch_size, j-k:j-k+overlap]

                err_patch = calculate_err(overlap_origin,overlap_sample)
                mask3 = cut(err_patch.T)
                mask3 = mask3.T

                h,w = mask3.shape
                mask3_extend = np.ones((patch_size,patch_size), dtype = "int
                for a in range(h):
                    for b in range(w):
                        if mask3[a,b] == 1:
                            mask3_extend[a,b] = 1
                        else:
                            mask3_extend[a,b] = 0

                # top overlaps part
                overlap_origin = output[h_left:h_left+overlap,w_left:w_left+
                overlap_sample = sample[i-k:i-k+overlap, j-k:j-k+patch_size]
                err_patch = calculate_err(overlap_origin,overlap_sample)
                mask4 = cut(err_patch)

                h,w = mask4.shape
                mask4_extend = np.ones((patch_size,patch_size), dtype = "int
                # convert int to float, cannot find easier way
                for a in range(h):
                    for b in range(w):
                        if mask4[a,b] == 1:
                            mask4_extend[a,b] = 1
                        else:
                            mask4_extend[a,b] = 0
                mask_combined = mask3_extend & mask4_extend
                # convert int to float, cannot find easier way, and convert
                mask_combined_handle = np.zeros((patch_size,patch_size,3), d
                for a in range(patch_size):
                    for b in range(patch_size):
                        if mask_combined[a,b] == 1:
                            for c in range(3):
                                mask_combined_handle[a,b,c] = 1.0
                        else:
                            for c in range(3):
                                mask_combined_handle[a,b,c] = 0.0
#                 plt.imshow(mask_combined_handle)
#                 plt.show()
                overlap_mix_extend = (1.0-mask_combined_handle) * template \
                + mask_combined_handle * sample[i-k:i-k+patch_size, j-k:j-k+
                output[h_left:h_left+patch_size,w_left:w_left+patch_size] =
    return output
```

In [22]:
```
res = quilt_cut(sample_img, 251, 31, 11, 0.00005)
plt.imshow(res[...,-1::-1]) # overlap 0.005 is not enough while 0.0005 is er
plt.title('quilt_cut')
plt.show()
```

```
121 10
```



part IV: Texture Transfer (30 pts)

In [128]:
```
import math
# Suppose I have a template T, a mask M, and an image I: then,
# ssd = ((M*T)**2).sum() - 2 * cv2.filter2D(I, ddepth=-1, kernel = M*T) + cv
def ssd_overlap(sample, patch_size, template, mask):
    """
    ssd_patch performs template matching with the overlapping region, comput
    each patch, based on the sum of squared differences (SSD) of the overlap
    and sampled patch.
    """
    sample_size = min(sample.shape[0],sample.shape[1])
    start_index = (patch_size-1) // 2
    end_index = (sample_size-1) - start_index # end index is 191-9=182, take
    ssd = ((mask*template)**2).sum() - 2 * cv2.filter2D(sample, ddepth=-1, k
#     plt.imshow(ssd.mean(2)) !!!!!!!!!!
#     plt.show()
    cost_image = np.zeros((sample_size,sample_size), dtype=np.float32)
    for i in range(start_index,end_index+1):
        for j in range(start_index,end_index+1):
            cost_image[i,j] = ssd[i,j].sum()
#     print("cost image")
#     print(cost_image)
#     plt.imshow(cost_image)
#     plt.show()
    return cost_image
```

In [96]:
```
def ssd_transfer(sample, patch_size, target_patch):
    sample_size = min(sample.shape[0],sample.shape[1])
    k = (patch_size-1) // 2
    start_index = (patch_size-1) // 2
    end_index = (sample_size-1) - start_index # end index is 191-9=182, take
    cost_image = np.zeros((sample_size,sample_size), dtype=np.float32)
    for i in range(start_index,end_index+1):
        for j in range(start_index,end_index+1):
            cost_image[i,j] = 0
            for m in range (-k,k+1):
                for n in range (-k,k+1):
                    cost_image[i,j] += abs(sample[i+m,j+n]-target_patch[k+m,
    return cost_image
```

In [105]:
```
def choose_sample(sample, patch_size, cost_image, tol):
    sample_size = min(sample.shape[0],sample.shape[1])
    # for sample.shape = (192,192,3) and patch_size = 19 and overlap = 5
    start_index = (patch_size-1) // 2 # start index is (19-1)/2=9
    end_index = (sample_size-1) - start_index  # end index is 191-9=182, tal
    minc = float("inf")
    # first to find the min cost
    for i in range (start_index,end_index+1):
        for j in range (start_index,end_index+1):
            if cost_image[i,j] < minc:
                minc = cost_image[i,j]
    compare_cost = minc*(1+tol)
    for i in range (start_index,end_index+1):
        for j in range (start_index,end_index+1):
            if cost_image[i,j] < compare_cost:
                return i,j
```

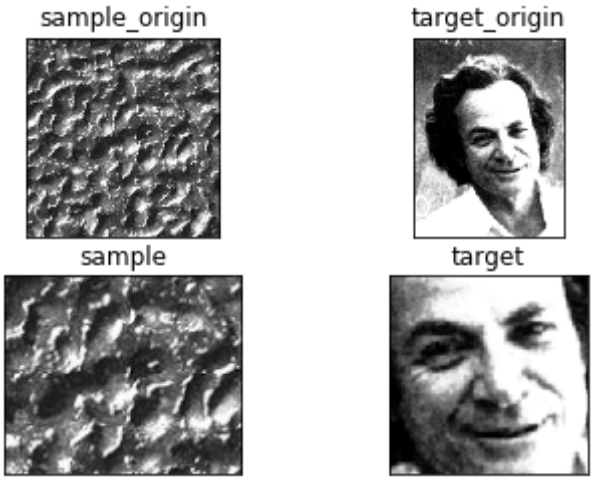
In [121]:
```
def texture_transfer(sample, target, patch_size, overlap, tol):
    """
    Samples square patches of size patchsize from sample using seam finding
    Feel free to add function parameters
    :param sample: numpy.ndarray
    :param out_size: int
    :param patch_size: int
    :param overlap: int
    :param tol: int
    :return: numpy.ndarray
    """
    target_size = target.shape
    out_size1 = target.shape[0]
    out_size2 = target.shape[1]
    output = np.zeros((out_size1,out_size2), dtype=np.float32)
    patch_size_remained = patch_size - overlap
    number1 = (out_size1 - patch_size) // patch_size_remained + 1 # the numb
    number2 = (out_size2 - patch_size) // patch_size_remained + 1 # the numb
    # Start by sampling a random patch for the upper-left corner.
    k = (patch_size-1) // 2
    target_patch_ini = target[0:0+patch_size,0:0+patch_size]
    cost_image_ini = ssd_transfer(sample, patch_size, target_patch_ini)
    a, b = choose_sample(sample, patch_size, cost_image_ini, tol)

    output[0:patch_size,0:patch_size] = sample[a:a+patch_size,b:b+patch_size
    print(a,b)
    # the second patch along the top row will overlap by patch_size
    # pixels in the vertical direction and overlap pixels in the horizontal
    for h_left_index in range (0,number1):
        for w_left_index in range (0,number2):
            # The mask has the same size as the patch template and
            # has values of 1 in the overlapping region and values of 0 else
            mask = np.zeros((patch_size,patch_size), dtype=np.float32)
            # the coordinate of the left_top point is (x_left_top*patch_size
            if (w_left_index == 0) and (h_left_index == 0):
                mask[:,0:overlap] = 1.0
                mask[0:overlap,:] = 1.0
                continue
            elif (h_left_index == 0):
                mask[:,0:overlap] = 1.0
            elif (w_left_index == 0):
                mask[0:overlap,:] = 1.0
            else:
                mask[:,0:overlap] = 1.0
                mask[0:overlap,:] = 1.0
            h_left = h_left_index * patch_size_remained
            w_left = w_left_index * patch_size_remained
            #  The template is the patch in the current output image that is
            # (many pixel values will be 0 because they are not filled in ye
            template = output[h_left:h_left+patch_size,w_left:w_left+patch_s
            target_patch = target[h_left:h_left+patch_size,w_left:w_left+pat
            cost_image1 = ssd_overlap(sample, patch_size, template, mask)
            cost_image2 = ssd_transfer(sample, patch_size, target_patch)
            cost_image = cost_image1*0.5 + cost_image2*0.5
            i ,j = choose_sample(sample, patch_size, cost_image, tol)
            # output[h_left:h_left+patch_size,w_left:w_left+patch_size] = sa
```

```
            # the same as the patch_size
            # added code for quilt_cost ------------------------------------
            # the situdation of left overlaps
            if (h_left_index == 0):
                overlap_origin = output[h_left:h_left+patch_size,w_left:w_le
                overlap_sample = sample[i-k:i-k+patch_size, j-k:j-k+overlap]

                err_patch = calculate_err(overlap_origin,overlap_sample)
                mask = cut(err_patch.T)
                mask = mask.T
                h,w = mask.shape
                mask_handle = np.zeros((h,w), dtype = np.float32)
                # convert int to float, can't find easier way
                for a in range(h):
                    for b in range(w):
                        if mask[a,b] == 1:
                            mask_handle[a,b] = 1.0
                        else:
                            mask_handle[a,b] = 1.0
                overlap_mix = overlap_origin*(1-mask_handle) + overlap_sampl
                output[h_left:h_left+patch_size,w_left:w_left+patch_size] =
                output[h_left:h_left+patch_size,w_left:w_left+overlap] = ove
            # the situdation of top overlaps
            elif (w_left_index == 0):
                overlap_origin = output[h_left:h_left+overlap,w_left:w_left+
#                 plt.imshow(overlap_origin[...,-1::-1])
#                 plt.show()
                overlap_sample = sample[i-k:i-k+overlap, j-k:j-k+patch_size]
#                 plt.imshow(overlap_sample[...,-1::-1])
#                 plt.show()
                err_patch = calculate_err(overlap_origin,overlap_sample)
#                 print("cost")
#                 plt.imshow(err_patch[...,-1::-1])
#                 plt.show()

                mask = cut(err_patch)
                h,w = mask.shape
                mask_handle = np.zeros((h,w), dtype = np.float32)
                # convert int to float, cannot find easier way
                for a in range(h):
                    for b in range(w):
                        if mask[a,b] == 1:
                            mask_handle[a,b] = 1.0
                        else:
                            mask_handle[a,b] = 1.0
#                 temp1 = overlap_origin*(1-mask_handle)
#                 plt.imshow(temp1[...,-1::-1])
#                 plt.show()
#                 temp2 = overlap_sample*mask_handle
#                 plt.imshow(temp2[...,-1::-1])
#                 plt.show()
                overlap_mix = overlap_origin*(1-mask_handle) + overlap_sampl
#                 plt.imshow(overlap_mix[...,-1::-1])
#                 plt.show()
                output[h_left:h_left+patch_size,w_left:w_left+patch_size] =
                output[h_left:h_left+overlap,w_left:w_left+patch_size] = ove
            # if a patch has top and left overlaps, you will need to compute
```

```
            # and the mask can be defined as the intersection of the masks i
            else:
                # left overlaps part
                overlap_origin = output[h_left:h_left+patch_size,w_left:w_le
                overlap_sample = sample[i-k:i-k+patch_size, j-k:j-k+overlap]

                err_patch = calculate_err(overlap_origin,overlap_sample)
                mask3 = cut(err_patch.T)
                mask3 = mask3.T

                h,w = mask3.shape
                mask3_extend = np.ones((patch_size,patch_size), dtype = "int
                for a in range(h):
                    for b in range(w):
                        if mask3[a,b] == 1:
                            mask3_extend[a,b] = 1
                        else:
                            mask3_extend[a,b] = 0

                # top overlaps part
                overlap_origin = output[h_left:h_left+overlap,w_left:w_left+
                overlap_sample = sample[i-k:i-k+overlap, j-k:j-k+patch_size]
                err_patch = calculate_err(overlap_origin,overlap_sample)
                mask4 = cut(err_patch)

                h,w = mask4.shape
                mask4_extend = np.ones((patch_size,patch_size), dtype = "int
                # convert int to float, cannot find easier way
                for a in range(h):
                    for b in range(w):
                        if mask4[a,b] == 1:
                            mask4_extend[a,b] = 1
                        else:
                            mask4_extend[a,b] = 0
                mask_combined = mask3_extend & mask4_extend
                # convert int to float, cannot find easier way, and convert
                mask_combined_handle = np.zeros((patch_size,patch_size), dty
                for a in range(patch_size):
                    for b in range(patch_size):
                        if mask_combined[a,b] == 1:
                            mask_combined_handle[a,b] = 1.0
                        else:
                            mask_combined_handle[a,b] = 1.0
#                   plt.imshow(mask_combined_handle)
#                   plt.show()
                overlap_mix_extend = (1.0-mask_combined_handle) * template \
                + mask_combined_handle * sample[i-k:i-k+patch_size, j-k:j-k+
                output[h_left:h_left+patch_size,w_left:w_left+patch_size] =
    return output
```

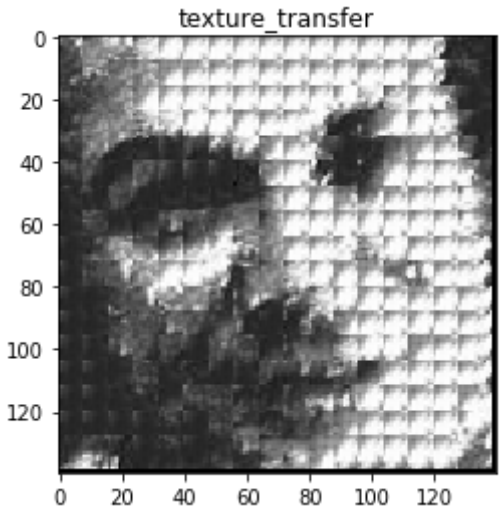
In [153]:
```
def read_image(image_path):
    intensity_image = cv2.imread(image_path, cv2.IMREAD_GRAYSCALE)
    return intensity_image.astype(np.float32) / 255
sample_file = "./samples/sample1.jpg"
target_file = "./samples/feynman.tiff"
sample = read_image(sample_file)
target = read_image(target_file)
fig, axes = plt.subplots(2, 2)
axes[0,0].imshow(sample,cmap='gray')
axes[0,0].set_title('sample_origin'), axes[0,0].set_xticks([]), axes[0,0].se
axes[0,1].imshow(target,cmap='gray')
axes[0,1].set_title('target_origin'), axes[0,1].set_xticks([]), axes[0,1].se
print(sample.shape)
print(target.shape)
sample = sample[sample.shape[0]//2-50:sample.shape[0]//2+50, sample.shape[1
target = target[target.shape[0]//2-50:target.shape[0]//2+90, target.shape[1
print(sample.shape)
print(target.shape)

axes[1,0].imshow(sample,cmap='gray')
axes[1,0].set_title('sample'), axes[1,0].set_xticks([]), axes[1,0].set_ytick
axes[1,1].imshow(target,cmap='gray')
axes[1,1].set_title('target'), axes[1,1].set_xticks([]), axes[1,1].set_ytick
```

```
(200, 196)
(355, 271)
(100, 120)
(140, 140)
```



In [154]:
```
res = texture_transfer(sample, target, 11, 3, 0.0005)
plt.imshow(res,cmap='gray')
plt.title('texture_transfer')
plt.show()
```

```
33 78
```



Bells & Whistles

(10 pts) Create and use your own version of cut.m. To get these points, you should create your own implementation without basing it directly on the provided function (you're on the honor code for this one).

You can simply copy your customized_cut(bndcost) into the box below so that it is easier for us to grade

In [ ]:
```
```

(15 pts) Implement the iterative texture transfer method described in the paper. Compare to the non-iterative method for two examples.

In [ ]:
```
```

(up to 20 pts) Use a combination of texture transfer and blending to create a face-in-toast image like the one on top. To get full points, you must use some type of blending, such as feathering or Laplacian pyramid blending.

In [ ]:

(up to 40 pts) Extend your method to fill holes of arbitrary shape for image completion. In this case, patches are drawn from other parts of the target image. For the full 40 pts, you should implement a smart priority function (e.g., similar to Criminisi et al.).

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: